PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Variable Speed Transmission Gear

I, WALTER BLAZO, of 780, North Fairoaks Avenue No. 44, Sunnyvale, California, United States of America, a citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a variable speed transmission gear and more particularly to a variable speed transmission gear which is automatically responsive to torque loading and is useful for transmitting torque from a power source to a driven load.

Transmission of various types are commonly used for transmitting power from a power input to a driven load. For example, they are commonly used for automotive vehicles, marine propulsion, farm machinery, and various other types of machinery wherein the power supplied passes through a transmission which converts it into a suitable output torque for the load requirements. It is common to use combinations of gears of various types to adjust the output torque and speed to the load requirements. Generally, output torque and speed are varied by such means as manual gear levers which select various gear ratios suitable to convert input power to required output torque, or hydraulic torque converters or the like, combined with gears, friction devices and hydraulic controls which may perform the same function automatically. The so-called automatic transmissions which in one way or another adjust the available input power to a required torque to meet load requirements are almost universally highly complicated, expensive, difficult to maintain and repair and bulky and heavy in weight. In addition, they are inherently inefficient and have inherent problems of heat dissipation.

Thus, it is an object of this invention to provide an automatic type variable speed transmission which is simplified, inexpensive, light weight, small, completely mechanical, constant mesh, stepless and infinitely variable and which self-adjusts immediately and progressively to variations in load below a known maximum.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a longitudinal, medial sectional view of a convenient form of transmission gear in accordance with this invention.

Fig. 2 is a fragmentary, cross-sectional view taken in the direction of arrows 2—2 of Fig. 1, the housing being omitted.

Fig. 3 is a cross-sectional view taken in the direction of arrows 3—3 of Fig. 1.

With reference particularly to Fig. 1, the transmission gear shown therein includes four major elements, namely, a housing 10, an input shaft 11, an output shaft 12, and an intermediate shaft 13. The housing 10, formed of a hollow cylinder 14, is arranged coaxial with the three shafts which are aligned end to end. The forward end of the housing is closed by means of an axially adjustable bearing retainer 15. The rear end is provided with a closure 16. Midway between the two ends is a partition 17. The closure 16 and partition 17 are secured to the housing cylinder 14 by means of screws 18 or by pressed fittings or the like.

The input shaft 11, which extends outwardly of the forward end of the housing, passes through an opening 19 in the retainer 15 and is rotatably supported therein by means of a suitable thrust bearing 20. The rear end of the input shaft is formed as a reduced throat 21 fitted into and rotatably supported by a ball bearing 22 arranged within a bore 23 in the forward end of the inter-

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mediate shaft 13. Likewise, the rear end of the intermediate shaft is also formed as a reduced throat 24 fitted into and rotatably supported by a bearing 25 supported within bore 26 at the forward end of output shaft 12. Output shaft 12 passes through an opening 27 in rear closure 16 and is rotatably supported therein by suitable ball bearings 28.

In the embodiment illustrated, the output shaft 12 is formed as a hollow shaft with an interior spline 29 for connection to a splined driven shaft which supplies power to the load (not illustrated). However, the output shaft may be formed solid as in the case of the input shaft.

The forward end of the intermediate shaft 13 is enlarged at 30 and passes through an opening 31 formed in the housing partition 17 and is rotatably supported therein by means of a ball bearing 32. Thus, it can be seen that each of the shafts is independently rotatable about its axis and that the shafts interfit and are arranged coaxial with each other as well as with the housing cylinder 14.

Suitable lock nuts are provided to hold the various bearings in position as shown in the drawing. In addition, a conventional high speed oil sealing means 35 held in place by a seal retainer 36 and an axially adjustable screw ring 37 is provided to seal the input shaft 11 to the retainer 15. A conventional slow speed oil seal 38 contained within a bearing closure 39 is provided to seal the output shaft 12 to the closure 16, to thus avoid leakage of lubricating oil which may be contained within the unit and to keep out dirt, etc. The specific form of sealing means for sealing the shaft to the housing closures and the locking nut means for holding the various bearings in position form no part of this invention.

A hub 40 is formed on the input shaft, the hub having a circular flat rim 41 so that it is disc-like or cylindrical in shape. The hub central axis 42 is canted at an acute angle relative to the input shaft central axis and in addition, the hub is arranged off center relative to the input shaft axis. Thus, as the input shaft rotates, the hub wobbles about the shaft axis with its axis generating a cone about the shaft axis. The forward end of the hub is provided with a continuous shoulder 43 at the rim edge. A ball thrust bearing 44 is mounted upon the rim and mounted upon the ball bearing is a ring 45 provided with a lip 46 which over-rides the rear end face of the ball bearing 44. The ring is provided with two annular face gears, namely an inner face gear 47 which is formed as a crown gear and an outer gear formed as a bevel gear 48, both gears being coaxial with the hub axis 42. As illustrated in the drawings, the ring 45 is formed of two concentric, interconnected parts, with the crown gear being on the inner part and the bevel gear being on the outer part, the two parts being secured together by any suitable key means. However, the ring may also be made in one piece since the two parts, in effect, function as one piece.

The enlarged portion 30 of the intermediate shaft 13 is formed with a bevel gear 49 whose axis is coincident with the shaft axis. This bevel gear is meshed with the crown gear 47 of the ring 45. In addition, a bevel gear 50 is formed on the forward face of the partition 17, whereby this bevel gear is fixed to the housing cylinder 14. The bevel gear 50 meshes with the outer bevel gear 48 of the ring 45.

The point at which the canted axis 42 of the hub 40 intersects the axis of the shaft 11 is common to the vertex of the pitch cone angle of the bevel gear 49 on the end of the intermediate shaft 13, the bevel gear 48, and the bevel gear 50. The angle of the canted axis is determined by conventional rules and formulas for bevel gearing wherein the angle between shafts is greater than 90 degrees and pitch cone angle of bevel gear 48 and crown gear 47 to 90 degrees or less. Thus, as the input shaft 11 rotates, the hub axis wobbles about the shaft axis with the hub axis generating a cone about the shaft axis.

A collar or hub 60 is fixed to the intermediate shaft 13, the hub having an outer cylindrical rim 61, and with its axis arranged at an acute angle and off-center relative to the axis of the intermediate shaft. The rim 61 is bounded at its forward end with a shoulder 63 and supports a ball bearing 64 upon which ring 65 is mounted. Ring 65 is provided with two face gears, namely, inner crown gear 67 and outer bevel gear 68, which mesh respectively with bevel gear 69 formed on the forward end of output shaft 12 and with a fixed bevel gear 70 formed on the closure 16.

The point at which the canted axis of the hub 60 intersects the axis of the shaft 13, is common to the vertex of the pitch cone angles of gears 68, 69 and 70. The angle of the canted axis is determined by conventional rules and formulas for bevel gearing wherein the angle between shaft axis and canted axis is greater than 90 degrees and pitch cone angle of bevel gear 70 is 90 degrees or less. Hence, hub 60 wobbles about its shaft axis as the shaft rotates and its axis swings to generate a cone about the shaft axis.

The tooth form of the various gears mentioned may be of any of the conventional involute types or it could be of some other suitable tooth form and either a straight tooth or spiral tooth configuration. The particular

tooth form selected will vary with the use and loads encountered.

While the number of teeth of each gear is a design matter, and would be selected by the designer in accordance with the desired torque and load capacity of the transmission one set of sample gears are given below for purposes of illustration.

SAMPLE GEARS

Gear No.	No. of Teeth.	Meshes with Gear No.	No. of Teeth.
47	33T	49	25T
48	44T	50	38T
67	33T	69	32T
68	44T	70	41T

In this construction, the various drive gears are rotatably mounted relative to their respective drive shafts. Hence, they impart turning forces to the driven gears by utilizing both the thrust and tangential force components, applied through the angle of obliquity of action or the tooth pressure angle. Thus, as torque is applied to input shaft 11, the crown gear 47 and bevel gear 48 mesh with the gear 50 and bevel gear 49 at a continuously changing radial position of pitch cone tangency, with the rate of change equal to input R.P.M. Therefore, for example only, if gear 48 and gear 50 have equal numbers of teeth, no radial change per revolution would occur in gear 48 or 47, then if gear 47 has a greater number of teeth than the number of gear teeth of gear 49, with which it is in mesh, each input revolution of shaft 11 would cause a radial change of position to the intermediate shaft 13, equal to the difference in the number of teeth. Thus, if gear 47 had 40 teeth and gear 49 had 39 teeth, a 1/40 of a revolution radial change of position would occur in the intermediate shaft 13. In conventional gearing wherein gears are keyed to their respective shafts, a gear ratio is determined by dividing the number of teeth on the larger gear by the number of teeth on the smaller gear. In the un-conventional gearing, embodied in this invention, wherein drive gears are not axially secured to their respective drive shafts, a gear ratio is determined by dividing the difference between the numbers of gear teeth on the large and small gears, by the numbers of teeth on the larger gear. The selection of the gear ratios then becomes a matter of design.

Operation

In order to describe the operation of this device, three general, but different conditions will be separately discussed as follows: direct drive, increase load on output shaft, increase RPM on input shaft.

Where the input power and the output load are so related that the housing turns at the same speed as the input shaft, the device herein generally acts as a shaft coupling, that is, the various gears and the entire unit including the input shaft, intermediate shaft and output shaft, various gears and housing all rotate together as a unit. Thus, the output shaft is directly connected or coupled to the input shaft and the output RPM is the same as the input RPM.

In a second general condition, where the input shaft is operating at a fixed RPM and an increased load is put upon the output shaft, then the output shaft slows down to operate at a lower RPM. When this happens, the reduced rotation of the output shaft bevel gear 69 causes gears 67—68 to rotate relative to the intermediate shaft upon which they are mounted and this drives housing bevel gear 70 to rotate the housing. The rotating housing causes the housing bevel gear 50 to rotate the gears 47—48 relative to the input shaft which in turn, because of the meshing between gear 47 and intermediate shaft bevel gear 49 causes the intermediate shaft to rotate. This in turn drives the gears 67—68 to drive the output shaft bevel gear 69. Thus, a complete circuit occurs and the RPM of the output shift is now adjusted to a lower RPM due to the effect of the gearing. All this time, the input shaft is operating at the same input RPM. Thus, the unit adjusts itself automatically and immediately to respond to variations in the load on the output shaft.

A third condition which occurs is where the output shaft is stationary and the unit is started in operation or where the operation is at one RPM and the input shaft is given a greater RPM to thus likewise effect the RPM. In this case, the gears 47—48 rotate relative to the input shaft 11 to thus drive the intermediate shaft bevel gear 49 and the intermediate shaft 13 and also to drive the housing bevel gear 50 to rotate the housing. The intermediate shaft rotation rotates gears 67—68. However, the second housing bevel gear 70 rotates at a different rate than the bevel gear 68, namely at the same rate as housing bevel gear 50 so that the gears 67—68 are slowed down somewhat by the action of the housing bevel gear 70. Then, crown gear 67, in meshing with output shaft bevel gear 69 drives the output shaft 12. In this manner, the unit quickly adjusts to the increased RPM.

For certain purposes it may be desirable to hold the housing against rotation to thus form it as a stationary housing. The transmission then functions as a fixed ratio, compound, speed reduction unit that is not variable. In this case, bevel gears 48 and 68 simply roll over the respective housing gears 50 and 70 with which they mesh rather than rotating the housing.

In so doing, housing gears 50 and 70 restrict radial turning moments of gears 47 and 48 and gears 68 and 67 and thereby

produce an unbalanced couple on gear 49 and gear 69 through which torque is transmitted.

WHAT I CLAIM IS:—

1. A variable speed transmission gear having a housing, an input shaft freely rotatable in the housing, a hub fixed to the shaft and carrying a first pair of gear wheels fixed together and freely rotatable with respect to the hub, with their common axis offset from and at an angle to the shaft, one gear wheel meshing with a gear wheel fixed to the housing, the other gear wheel meshing with a gear wheel fixed to an intermediate shaft freely rotatable in the housing; a hub fixed to the intermediate shaft and carrying a second pair of gear wheels fixed together and freely rotatable with respect to their hub, with their common axis offset from and at an angle to the intermediate shaft, one of the second pair of gear whls mshing with a gear wheel fixed to the housing while the second meshes with a gear wheel fixed to an output shaft freely rotatable in the housing.

2. A variable speed transmission gear according to claim 1 in which the three shafts are coaxial.

3. A variable speed transmission gear according to claim 2 in which the housing is rotatable about the common axis of the three shafts.

4. A variable speed transmission gear according to any one of the preceding claims in which each hub carries a ball bearing the axis of which forms an acute angle with the shaft on which the hub is mounted, the bearing carrying the pair of gear wheels associated with the shaft.

5. A variable speed transmission gear according to any one of the preceding claims in which during at least one phase of the operation of the transmission gear the housing is held against rotation.

6. A variable speed transmission gear according to any one of the preceding claims in which at least half of the gears are bevel gears and in which a hub axis intersects its shaft axis at a point common to the vertex of the pitch cone of the gear wheels mounted on the hub.

7. A variable speed transmission gear according to any one of the preceding claims in which the housing is supported on and carried by the input and output shafts.

8. A variable speed transmission gear according to any one of the preceding claims, substantially as described and illustrated in the accompanying drawings.

POTTS & CO.

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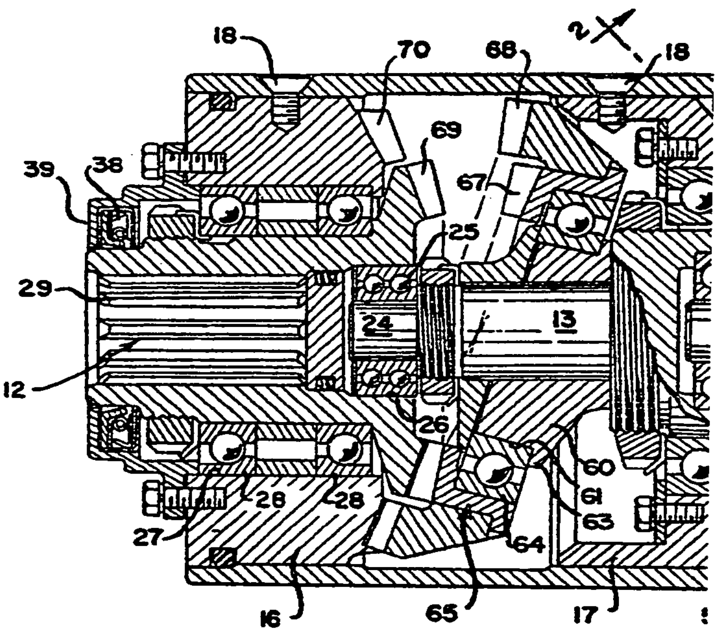

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FIG_1

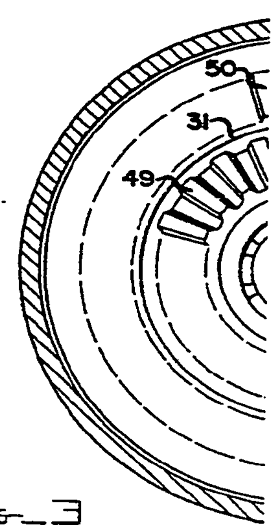

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FIG_3

1069814 COMPLETE SPECIFICATION

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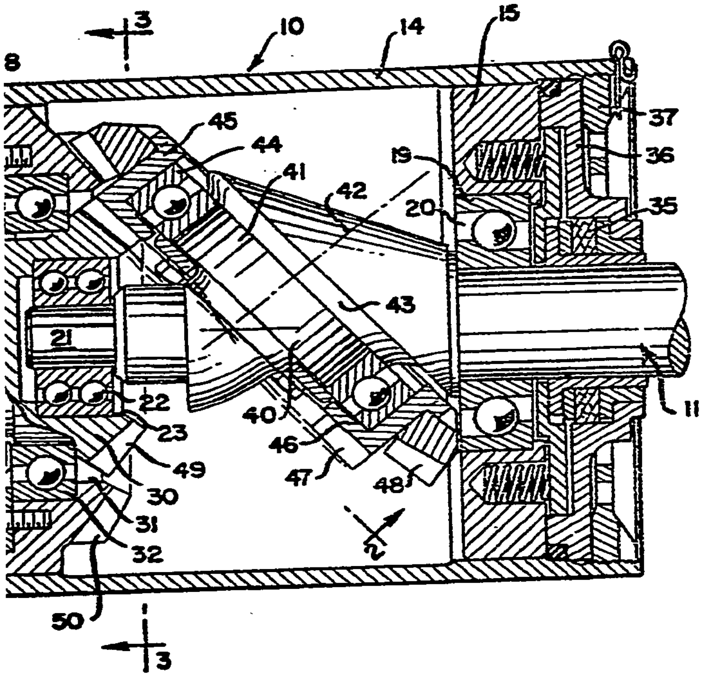

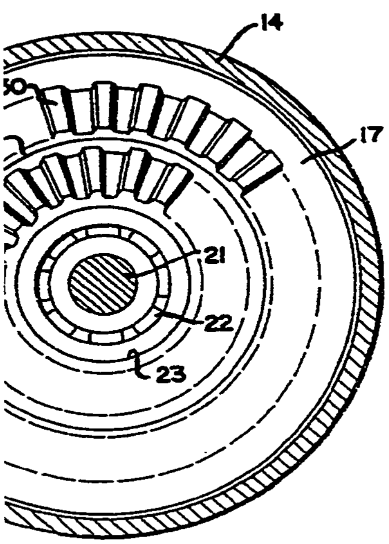

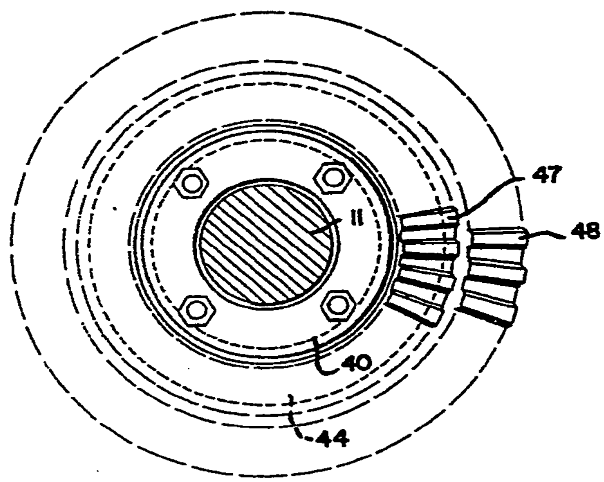

FIG_2

1069814 COMPLETE SPECIFICATION

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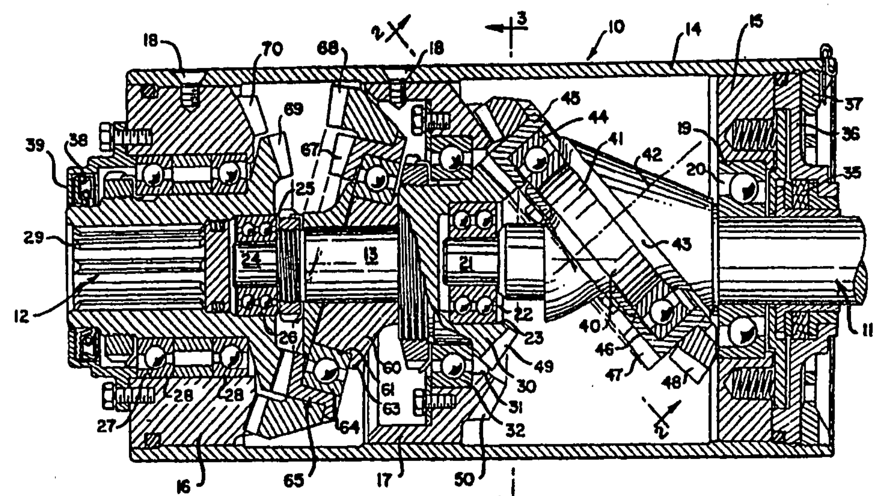

FIG_1

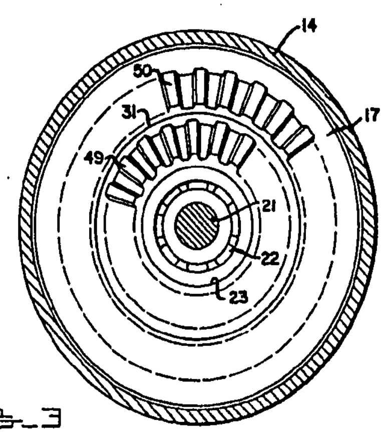

FIG_3

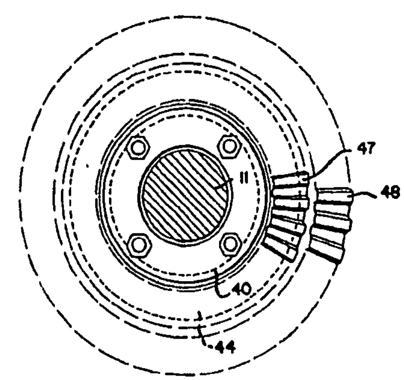

FIG_2